**WHAT IS CLAIMED IS:**

1. A slip control system of an automatic transmission with a torque converter, comprising:

a lockup clutch, which is disposed between input and output elements of the torque converter, and whose engagement capacity is changeable for adjusting an actual slip-rotation speed between the input and output elements; and

a control unit that feedback-controls the engagement capacity, the control unit comprising:

(a) a target slip-rotation speed calculation section that estimates a target slip-rotation speed based on engine-and-vehicle operating conditions;

(b) a pre-compensating section that pre-compensates for the target slip-rotation speed to produce a target slip-rotation speed correction value;

(c) a slip-rotation speed deviation calculation section that calculates a slip-rotation speed deviation between the target slip-rotation speed correction value and the actual slip-rotation speed;

(d) a feedback compensating section that feedback-controls the engagement capacity based on the slip-rotation speed deviation to bring the actual slip-rotation speed closer to the target slip-rotation speed; and

(e) a dead-time processing section that compensates for the target slip-rotation speed correction value, considering a dead time of dynamic characteristics peculiar to the slip control system in the target slip-rotation speed correction value, to supply a dead-time compensated output to the feedback compensating section.

2. The slip control system as claimed in claim 1, wherein:

the slip control system comprises a feedforward control system that controls the engagement capacity by open-loop control for a first time period of an automatically locked-up time period during which the lockup clutch shifts from a release state to a fully-engaged state, and a feedback control system that controls the engagement capacity by closed-loop control for a second time period of the automatically locked-up time period, and

wherein at a switching point from the open-loop control to the closed-loop control the pre-compensating section is initialized and simultaneously the dead time is reset to zero, and the dead time is variably adjusted to gradually increase from zero to a predetermined dead-time equivalent value peculiar to the slip control system with a predetermined transition time period from the switching point.

3. The slip control system as claimed in claim 2, wherein:

the predetermined transition time period is determined depending on a time rate of increase in the engagement capacity controlled by open-loop control during the first time period.

4. The slip control system as claimed in claim 3, wherein:

the predetermined transition time period lengthens, as the time rate of increase in the engagement capacity controlled by open-loop control increases.

5. The slip control system as claimed in claim 2, wherein:

the predetermined transition time period is determined depending on the engagement capacity controlled by open-loop control during the first time period.

6. The slip control system as claimed in claim 5, wherein:

the predetermined transition time period lengthens, as the engagement capacity controlled by open-loop control increases.

7. A slip control system of an automatic transmission with a torque converter, comprising:

a lockup clutch, which is disposed between input and output elements of the torque converter, and whose engagement capacity is changeable for adjusting an actual slip-rotation speed between the input and output elements; and

a control unit that feedback-controls the engagement capacity of the lock-up clutch, the control unit comprising:

(a) a target slip-rotation speed calculation section that estimates a target slip-rotation speed based on engine-and-vehicle operating conditions;

(b) a pre-compensating section that pre-compensates for the target slip-rotation speed to produce a target slip-rotation speed correction value;

(c) a slip-rotation speed deviation calculation section that calculates a slip-rotation speed deviation between the target slip-rotation speed correction value and the actual slip-rotation speed;

(d) a feedback compensating section that feedback-controls the engagement capacity of the lock-up clutch based on the slip-rotation speed deviation to bring the actual slip-rotation speed closer to the target slip-rotation speed; and

(e) a dead-time processing section that compensates for the target slip-rotation speed correction value to reflect a dead time of dynamic characteristics peculiar to the slip control system in the target slip-rotation speed correction

value, and supplies a dead-time compensated output to the feedback compensating section, the dead time being variable in accordance with a predetermined dead time characteristic.

8. The slip control system as claimed in claim 7, wherein:

the slip control system comprises a feedforward control system that controls the engagement capacity by open-loop control for a first time period of an automatically locked-up time period during which the lockup clutch shifts from a release state to a fully-engaged state, and a feedback control system that controls the engagement capacity by closed-loop control for a second time period of the automatically locked-up time period, and

wherein at a switching point from the open-loop control to the closed-loop control the pre-compensating section is initialized, so that the target slip-rotation speed correction value is initialized to the actual slip-rotation speed obtained at the switching point to the feedback control, and simultaneously the dead time is reset to zero, and the dead time is variably adjusted to gradually increase from zero to a predetermined dead-time equivalent value peculiar to the slip control system with a predetermined transition time period from the switching point.

9. The slip control system as claimed in claim 8, wherein:

the predetermined transition time period is determined depending on at least one of the engagement capacity controlled by open-loop control during the first time period and a time rate of increase in the engagement capacity controlled by open-loop control during the first time period.

10. The slip control system as claimed in claim 9, wherein:

the predetermined transition time period lengthens, as at least one of the engagement capacity controlled by open-loop control and the time rate of increase in the engagement capacity controlled by open-loop control increases.

11. A slip control system of an automatic transmission with a torque converter, comprising:

a lockup clutch, which is disposed between input and output elements of the torque converter, and whose engagement capacity is changeable for adjusting an actual slip-rotation speed between the input and output elements;

a slip control valve that is responsive to a signal pressure for changing a differential pressure between a lockup-clutch apply pressure and a lockup-clutch release pressure;

a lockup solenoid valve that generates the signal pressure in response to a drive signal for changing the differential pressure via the slip control valve; and

a control unit that feedback-controls the engagement capacity of the lock-up clutch by outputting the drive signal to the lockup solenoid valve, the control unit comprising:

(a) a target slip-rotation speed calculation section that estimates a target slip-rotation speed based on engine-and-vehicle operating conditions;

(b) a pre-compensating section comprising (i) a first compensating filter that pre-compensates for the target slip-rotation speed to produce a first target slip-rotation speed correction value corresponding to a reference-model output from an expression $\omega_{SLPTC1} = G_R(s) \times \omega_{SLPT}$ where $\omega_{SLPTC1}$ is the first target slip-rotation speed correction value, $G_R(s)$ is a reference model that is set as a transfer function suited to a desired response determined based on

designer's wishes, and $\omega_{SLPT}$ is the target slip-rotation speed, and (ii) a second compensating filter that pre-compensates for the target slip-rotation speed to produce a second target slip-rotation speed correction value from an expression $\omega_{SLPTC2} = G_M(s)\times\omega_{SLPT}$ where $G_M(s)$ corresponds to a feed-forward compensator, which is defined by an expression $G_M(s)=G_R(s)/P(s)$, where $G_R(s)$ is the reference model and $P(s)$ is a transfer function that is obtained by modeling a lockup-clutch slip-rotation section serving as a controlled system;

(c) a slip-rotation speed deviation calculation section that calculates a slip-rotation speed deviation between the target slip-rotation speed correction value and the actual slip-rotation speed;

(d) a feedback compensating section that feedback-controls the engagement capacity of the lock-up clutch based on the slip-rotation speed deviation to bring the actual slip-rotation speed closer to the target slip-rotation speed, the feedback compensating section comprising a feedback compensator that produces a first slip-rotation speed command value suited to reduce the slip-rotation speed deviation and an adder that produces a slip-rotation speed command value by adding the first slip-rotation speed command value to the second target slip-rotation speed correction value;

(e) a dead-time processing section that compensates for the first target slip-rotation speed correction value to reflect a dead time of dynamic characteristics peculiar to the slip control system in the first target slip-rotation speed correction value, and supplies a dead-time compensated output to the feedback compensator, the dead time being variable in accordance with a predetermined dead time characteristic; and

(f) a drive signal determination section that determines the drive signal based on the slip-rotation speed command value.

12. The slip control system as claimed in claim 11, wherein:

the feedback compensator comprises a proportional-plus-integral controller that is defined by an expression $\omega_{SLPC1} = K_P \cdot \omega_{SLPER} + (K_I/s) \cdot \omega_{SLPER}$ where $K_P$ is a proportional gain, $K_I$ is an integral gain, s is a differential operator, and $\omega_{SLPER}$ is the slip-rotation speed deviation.

13. The slip control system as claimed in claim 12, wherein:

the slip control system controls the engagement capacity by open-loop control for a first time period of an automatically locked-up time period during which the lockup clutch shifts from a release state to a fully-engaged state, and controls the engagement capacity by closed-loop control for a second time period of the automatically locked-up time period, and

wherein at a switching point from the open-loop control to the closed-loop control the first compensating filter is initialized, so that the first target slip-rotation speed correction value is initialized to the actual slip-rotation speed obtained at the switching point to the feedback control, and simultaneously the dead time is reset to zero, and the dead time is variably adjusted to gradually increase from zero to a predetermined dead-time equivalent value peculiar to the slip control system with a predetermined transition time period from the switching point.

14. The slip control system as claimed in claim 13, wherein:

the predetermined transition time period is determined depending on at least one of the engagement capacity controlled by open-loop control during the first time period and a time rate of increase in the engagement capacity controlled by open-loop control during the first time period.

15. The slip control system as claimed in claim 14, wherein:

the predetermined transition time period lengthens, as at least one of the engagement capacity controlled by open-loop control and the time rate of increase in the engagement capacity controlled by open-loop control increases.

16. The slip control system as claimed in claim 13, wherein:

the predetermined transition time period is determined depending on at least one of the differential pressure produced by open-loop control during the first time period and a time rate of increase in the differential pressure controlled by open-loop control during the first time period.

17. The slip control system as claimed in claim 16, wherein:

the predetermined transition time period lengthens, as at least one of the differential pressure produced by open-loop control and the time rate of increase in the differential pressure produced by open-loop control increases.

18. A slip control system of an automatic transmission with a torque converter, comprising:

a lockup clutch, which is disposed between input and output elements of the torque converter, and whose engagement capacity is changeable for adjusting an actual slip-rotation speed between the input and output elements; and

a control unit that feedback-controls the engagement capacity, the control unit comprising:

(a) a target slip-rotation speed calculation means for estimating a target slip-rotation speed based on engine-and-vehicle operating conditions;

(b) a pre-compensating means for pre-compensating for the target slip-rotation speed to produce a target slip-rotation speed correction value;

(c) a slip-rotation speed deviation calculation means for calculating a slip-rotation speed deviation between the target slip-rotation speed correction value and the actual slip-rotation speed;

(d) a feedback compensating means for feedback-controlling the engagement capacity based on the slip-rotation speed deviation to bring the actual slip-rotation speed closer to the target slip-rotation speed; and

(e) a dead-time processing means for compensating for the target slip-rotation speed correction value, considering a dead time of dynamic characteristics peculiar to the slip control system in the target slip-rotation speed correction value, to supply a dead-time compensated output to the feedback compensating section.

19. A method of controlling a speed of relative rotation between input and output elements of a lockup torque converter of an automatic transmission employing a lockup clutch, which is disposed between the input and output elements, and whose engagement capacity is changeable for

adjusting an actual slip-rotation speed between the input and output elements, the method comprising:

estimating a target slip-rotation speed based on engine-and-vehicle operating conditions;

pre-compensating for the target slip-rotation speed to produce a target slip-rotation speed correction value;

calculating a slip-rotation speed deviation between the target slip-rotation speed correction value and the actual slip-rotation speed;

feedforward-controlling the engagement capacity by open-loop control for a first time period of an automatically locked-up time period during which the lockup clutch shifts from a release state to a fully-engaged state;

feedback-controlling the engagement capacity of the lock-up clutch based on the slip-rotation speed deviation to bring the actual slip-rotation speed closer to the target slip-rotation speed for a second time period of the automatically locked-up time period; and

compensating for the target slip-rotation speed correction value to reflect a dead time of dynamic characteristics peculiar to a slip control system in the target slip-rotation speed correction value, the dead time being variable in accordance with a predetermined dead time characteristic, so that at a switching point from the feedforward control to the feedback control the dead time is reset to zero, and that the dead time is variably adjusted to gradually increase from zero to a predetermined dead-time equivalent value peculiar to the slip control system with a predetermined transition time period from the switching point.

20. The method as claimed in claim 19, wherein:

the predetermined transition time period lengthens, as at least one of the engagement capacity controlled by open-loop control and a time rate of increase in the engagement capacity controlled by open-loop control increases.